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Introduction

Content

Technical Specification for the Evaluation of Carbon Labels of Alcoholic Beverage Products

1 Overview

1.1 Scope

This document specifies methods for quantifying the carbon footprint of alcoholic beverages throughout their life cycle, including raw material acquisition, production and processing, packaging, transportation and distribution, retail and consumption, end-of-life treatment

It also provides a graded evaluation framework for carbon labeling applicable to: self-assessment by enterprises, third-party certification

1.2 Purpose

This document aims to:

a) Establish a GIS-LCA-based carbon accounting methodology

b) Define carbon emission thresholds aligned with industry average and best practices

c) Classify carbon labels into five grades (A+ to D)

d) Promote international mutual recognition of carbon footprint data

e) Encourage emission reduction and green consumption

2 Normative References

The following referenced documents are indispensable:

ISO 14021—Environmental labels and declarations

ISO 14040—Life cycle assessment principles

ISO 14044—LCA requirements and guidelines

ISO 14064-3—GHG validation and verification

ISO 14067—Carbon footprint of products

PAS 2050—Life cycle GHG emissions

3 Terms and definitions

3.1 Alcohol Beverages

Products containing ethanol and distributed as commodities.

3.2 Carbon Footprint of a Product; CFP

Total GHG emissions and removals expressed as CO_2equivalent over the life cycle.。

(Source: ISO 14067—2018，3.1.1)

3.3 Functional Unit

Reference unit for quantifying system performance. Typically defined as 1 liter of product in sale condition.

3.4 Carbon Label

A label indicating carbon footprint information via packaging or digital means.

3.5 Graded Evaluation

The process of classifying the carbon footprint reflected on the carbon labels of alcoholic products in accordance with specified indicators and methodologies, to indicate the relative performance of unit product carbon emissions.

3.6 Life Cycle Assessment

Compilation and evaluation of environmental impacts over a product life cycle。
（Source: ISO 14044:2022，3.2）

3.7 GIS-LCA Methodology

A spatially explicit LCA integrating Geographic Information Systems

3.8 Carbon Dioxide Equivalent;CO2e

Metric for comparing GHG emissions based on global warming potential.
（Source: ISO 14067:2018，3.1）

4 General Principles for Grading

4.1 Principles

4.1.1 Scientific Validity

Carbon emissions of alcoholic beverages shall be quantified accurately across all life cycle stages based on the GIS-LCA methodology, ensuring that grading results are objective and reliable.

The quantification shall cover at least 95 % of the anticipated greenhouse gas (GHG) emissions and removals associated with the functional unit over the life cycle.

GHG emissions or removals that individually account for less than 1 % of the total estimated GHG emissions or removals of the product may be excluded, provided that the cumulative excluded amount does not exceed 5 %.

All excluded emissions and removals shall be documented. The impact of the selected cut-off criteria on the quantification results shall be explained in the carbon footprint report.

4.1.2 Transparency

The carbon footprint data presented on the carbon label, as well as the grading evaluation process, shall be transparent and accessible to consumers, regulatory authorities, and other relevant stakeholders for the purpose of information disclosure and supervision.

4.1.3 Consistency

For different types of alcoholic beverages, a consistent set of grading evaluation indicators and methodologies should be applied under the same market boundary to ensure standardized and uniform evaluation results. For products within the same category, enterprises of different scales shall adopt consistent accounting approaches to ensure fairness and comparability of data.

4.1.4 Comparability

For different categories of alcoholic beverages, such as distilled spirits and fermented beverages, evaluation and comparison should be conducted in accordance with established national, industry, or regional carbon accounting standard.

4.1.5 Incentive orientation

The graded evaluation of carbon labeling should encourage alcoholic beverage enterprises to actively adopt low-carbon measures, continuously optimize production processes, reduce carbon emissions, and promote the overall green development of the industry.

4.2 Grading methodology and supervision

4.2.1 Grading methodology

A scoring system based on a 100-point scale shall be applied. Evaluation indicators shall be established and assigned corresponding scores across the following three dimensions:

a) accuracy of carbon footprint quantification;
b) level of low-carbon performance;
c) carbon emission reduction measures and their effectiveness.

Based on the final score, carbon labels for alcoholic beverages shall be classified into five grades, in descending order:

A+, A, B, C, and D.

The relationship between score ranges and grading levels shall be as follows:

a) Grade A+ (90–100 points): indicates outstanding carbon performance, with excellent carbon management practices demonstrating industry-leading low-carbon performance.
b) Grade A (80–89 points): indicates relatively advanced carbon performance, where effective carbon reduction measures have been implemented with demonstrable results.
c) Grade B (60–79 points): indicates performance approximately at the industry average level, with basic carbon management measures in place, but with significant potential for further emission reduction.

d) Grade C (40–59 points): indicates relatively poor carbon performance, requiring strengthened carbon management and the adoption of more effective emission reduction measures.
e) Grade D (0–39 points): indicates poor carbon performance, reflecting serious deficiencies in carbon reduction practices and requiring comprehensive corrective actions.

4.2.2 Supervision

For carbon label grading evaluations conducted in accordance with this document, including both self-assessments by enterprises and third-party assessments, the relevant authority shall have the right to conduct supervision and re-evaluation.

Where inaccuracies, data falsification, or non-compliance are identified, corrective actions shall be required. The grading shall be reassessed and the final grade re-determined in accordance with the requirements of this document.

5 Evaluation indicators and scoring for carbon label grading

5.1 Basis for grading

Carbon label grading evaluation should be based on a full life cycle assessment.

The evaluation shall be based on data from the most recent complete reporting year prior to application. The influence of externally purchased carbon credits shall be excluded.

Enterprises applying for evaluation shall demonstrate that no major carbon-related compliance incidents have occurred within the previous three years, including but not limited to:

a) failure to surrender carbon emission allowances within the government-specified quantity and compliance timeline for the previous year;
b) being ordered by regulatory authorities to suspend or cease operations, or being subject to a single administrative penalty exceeding a specified threshold, or being publicly criticized by municipal-level or higher authorities at the place of registration;
c) being subject to formal regulatory warnings, supervisory actions, or compliance enforcement measures by competent authorities.

5.2 Evaluation Indicators and Scoring

Evaluation indicators and scoring criteria shall be established across the following three dimensions: accuracy of carbon footprint quantification; level of low-carbon performance; carbon emission reduction measures and their effectiveness.

The detailed indicators and scoring rules shall be specified in Table 1.

Table1 Evaluation Indicators and Scoring

Primary indicator	Secondary indicator	Scoring criteria
Accuracy of carbon	Reliability and accuracy	Data shall be derived from calibrated enterprise-owned monitoring equipment, continuous emission monitoring systems

footprint quantification (30 points)	of data sources (15 points)	(CEMS), or entirely from internationally or nationally recognized authoritative databases. All key activity data (e.g. energy consumption, material consumption) shall be supported by complete and verifiable traceability records (e.g. invoices, production logs, metering reports, transport documents). 13–15 points: Data are primarily sourced from authoritative databases; key activity data are directly traceable; a small portion of non-critical data may be estimated using industry-recognized methods; the calculation error rate shall be ≤ 5 %. 10–12 points: Most data are sourced from authoritative databases or industry-average data; key activity data are reliably recorded; some data are reasonably estimated; the calculation error rate shall be within 6 % to 8 %.。 7–9 points: Data are mainly based on industry-average values and reasonable estimations, with clear justification; the calculation error rate shall be within 8 % to 9 %.。 4–6 points: Approximately half of the data are from verifiable sources, while the remaining data rely on estimations or non-specific data; the calculation error rate shall be within 9 % to 10 %. 0–3 points: Data reliability is poor, with extensive use of non-specific or insufficiently verified data (e.g. generic default values); the calculation process is coarse; the calculation error rate shall be > 10 %.
	Scientific validity of quantification methodology (15 points)	11–15 points: A GIS-LCA methodology or an industry-compliant carbon quantification model is applied, with appropriate parameter selection. 5–10 points: The quantification methodology is generally reasonable but has significant potential for improvement. 0–4 points: The quantification methodology is inappropriate and cannot accurately reflect product carbon emissions.
performance (40 points)	Carbon footprint per unit product (20 points)	“Industry-leading benchmark” and “industry-average benchmark” shall be determined based on publicly available standards or databases recognized by authoritative institutions. The priority order shall be: national or industry standards > officially

		published or industry association benchmark reports > publicly disclosed data of leading enterprises verified by third parties. 16–20 points: Carbon footprint per unit product ≤ industry-leading benchmark; where the value is ≤ 50 % of the industry-leading benchmark, a full score of 20 points shall be assigned. 11–15 points: Industry-leading benchmark < carbon footprint per unit product ≤ industry-average benchmark 6–10 points: Industry-average benchmark < carbon footprint per unit product ≤1.2×industry-average benchmark.。 0–5 points: 1.2×industry-average benchmark < carbon footprint per unit product ≤1.5×industry-average benchmark.

Table 1 (continued)

	Carbon emission reduction rate compared to baseline year (20 points)	The baseline year shall be the complete calendar year immediately preceding the evaluation year. The carbon emission reduction rate shall be calculated as follows: (see formula below). For enterprises applying for certification for the first time, where baseline data are unavailable, a default score of 10 points should be assigned. For enterprises that have continuously implemented carbon reduction measures for more than three years and are officially recognized by government or industry as benchmark enterprises for carbon reduction, a full score of 20 points should be assigned. 16–20 points: 5 % ≤ carbon emission reduction rate ≤ 30 %; where the reduction rate is ≥ 30 %, a full score of 20 points shall be assigned. 11–15 points: 3 % ≤ carbon emission reduction rate < 5 %. 6–10 points: 0 < carbon emission reduction rate < 3 %. 5 points: No reduction or an increase in carbon emissions. 0 points: Failure to achieve carbon reduction, with a measurable increase in emissions
Carbon emission reduction measures	Energy management measures	The enterprise shall establish an effective energy management system, including the adoption of clean energy (e.g. solar, wind, hydropower) to replace fossil fuels. 8–10 points: The proportion of clean energy in total energy consumption is ≥ 50 %, and energy efficiency has improved by

and effectiveness (30 points)	(10 points)	more than 10 % compared with the baseline year through measures such as equipment upgrades and process optimization. 5–7 points: The proportion of clean energy is between 30 % and 50 %, and energy efficiency has improved to a certain extent compared with the baseline year. 1–4 points: The proportion of clean energy is < 30 %; basic energy monitoring capability exists, and key equipment is subject to real-time metering.
	Raw materials and supply chain management (10 points)	8–10 points: Green core raw materials: major raw materials (accounting for > 50 % by mass) are certified as organic or meet equivalent authoritative sustainable agriculture certifications. Supply chain data transparency: carbon emission data reporting requirements (at least Scope 1 and Scope 2 emissions) are imposed on major suppliers representing ≥ 70 % of procurement value, and such data are systematically collected and used in carbon footprint accounting. A formal green supply chain management system is established, including periodic environmental performance evaluation of key suppliers with clear improvement and phase-out mechanisms. 6–7 points: Partial green raw materials: some raw materials (20 %–50 % by mass) are certified. Initial supply chain carbon management: carbon data reporting requirements are imposed on suppliers representing ≥ 50 % of procurement value, with partial data collection initiated but not yet fully implemented or normalized. Preliminary green supplier selection mechanisms or management documents are established.。 4–5 points: Initial implementation of green procurement: procurement standards for green raw materials (e.g. organic or eco-certified products) are defined and partially applied (< 20 % share). Supply chain carbon management initiated: preliminary supplier carbon assessments or data collection initiatives covering ≥ 30 % of procurement value are conducted, but stable data flows are not yet established. Environmental considerations are incorporated into procurement contracts. 1–3 points: No certified green raw materials are used; local sourcing may be preferred to reduce transport emissions. No formal supply chain carbon data management is implemented.

		The enterprise has initiated internal carbon accounting for direct production emissions and has preliminary awareness of green supply chain concepts, but no formal system is established.

Table 1 (continued)

	Waste treatment and circular utilization (10 points)	8–10 points: A comprehensive waste recycling system is established. Waste generated during production (e.g. distillers' grains, bottles) is effectively recycled and reused. The combined utilization rate of wastewater and solid waste is ≥ 90 %. Non-recyclable waste is treated in an environmentally sound manner. 5–7 points: The combined utilization rate of wastewater and solid waste is between 70 % and 90 %. Non-recyclable waste is treated in compliance with applicable requirements. 1–4 points: The combined utilization rate of wastewater and solid waste is < 70 %. Treatment of non-recyclable waste generally meets requirements but shows multiple irregularities or deficiencies.

6 Carbon label presentation

6.1 Placement and size

The carbon label should be displayed on the front or side of the alcoholic beverage packaging, where it is readily visible to consumers at the point of purchase.

The size of the label should be appropriately determined according to the dimensions of the packaging to ensure clarity and legibility.

6.2 Content

The carbon label shall include key information such as the grading level, carbon emission data, and traceability information, including but not limited to the following:

a) the carbon label grade (e.g. "A+", "A", "B", "C", "D") shall be prominently displayed, with font size and formatting designed to ensure clear visibility;

b) the total carbon emissions of the product over its full life cycle shall be clearly indicated, expressed in carbon dioxide equivalent (CO_2e), and reported to one decimal place. Where applicable, a brief description of the system boundary and quantification methodology should be provided;

c) a traceability mechanism, such as a QR code or equivalent digital identifier, shall be provided. By scanning or entering the relevant information, users shall be able to access detailed carbon footprint information, including emissions across life cycle stages and the carbon reduction measures implemented by the enterprise.

6.3 Colour and design

The colour scheme of the carbon label should be consistent with the overall packaging design and shall differentiate grading levels to enhance visual recognition.

The following colour coding is recommended:

a) Green for Grade A+ and Grade A, indicating low-carbon and environmentally friendly performance;
b) Yellow for Grade B, indicating average performance;
c) Red for Grade C and Grade D, indicating relatively high carbon emissions.
d) The label design should be simple and clear, avoiding overly complex graphics or excessive textual content, in order to ensure effective communication of information.

7 Surveillance and management

7.1 Competence of certification bodies

Certification bodies responsible for the graded evaluation and certification of carbon labels for alcoholic beverages shall possess appropriate professional qualifications.

Such bodies shall be accredited or authorized by a recognized competent authority or an internationally recognized accreditation body.

a) Certification bodies shall:
b) have qualified technical personnel;
c) demonstrate expertise in alcoholic beverage production processes;
d) possess competence in carbon footprint quantification methodologies;
e) have relevant experience in carbon footprint assessment and certification

7.2 Certification process

7.2.1 Application

Alcoholic beverage producers shall submit an application for carbon label grading certification to a certification body, together with relevant documentation, including:

a) general enterprise information;
b) product production process description;
c) carbon footprint quantification report.

As a general rule, products from the same enterprise, of the same type and specification, shall be considered as one certification unit.

Where products of the same type and specification are produced at different production sites, they shall be treated as separate certification units.

7.2.2 Document review

The certification body shall review the submitted documentation to verify:

a) completeness of the information;
b) accuracy of data;
c) appropriateness of the quantification methodology.

Where deficiencies are identified, the applicant shall be requested to provide supplementary information or corrections.

7.2.3 On-site verification

Following successful document review, the certification body shall conduct on-site verification. This shall include:

a) verification of consistency between actual production conditions and submitted documentation;

b) assessment of the implementation and effectiveness of carbon emission reduction measures.

7.2.4 Evaluation and certification

Based on the results of document review and on-site verification, the certification body shall conduct a grading evaluation in accordance with the requirements and criteria specified in this document.

Where the product meets the requirements for a given grade, a certification body shall:

a) issue a carbon label grading certificate;

b) authorize the use of the corresponding carbon label on product packaging.

7.3 Surveillance

Certified enterprises and products shall be subject to periodic surveillance by a competent authority or its authorized body.

Surveillance activities shall include:

a) verification of the authenticity of carbon emission data;

b) assessment of the continued effectiveness of carbon reduction measures;

c) verification of compliance of carbon label usage.

Where non-conformities are identified, appropriate actions shall be taken depending on severity, including:

a) issuance of warnings;

b) suspension of certification;

c) withdrawal of certification.

d) Such actions may be publicly disclosed where appropriate.

7.4 Complaints and handling

A complaint handling mechanism shall be established to receive complaints from consumers, social organizations, and other stakeholders regarding carbon label grading certification.

A competent authority or its designated body shall:

a) receive and process complaints;

b) conduct investigation and verification;

c) implement appropriate corrective actions where complaints are substantiated.

These measures shall ensure the fairness, credibility, and authority of the carbon label grading system.。

8 Implementation and revision of the standard

8.1 Implementation date

This document shall enter into force on the date of its publication.

Alcoholic beverage producers are encouraged to implement the requirements of this document in advance and to carry out carbon label grading evaluation activities in order to enhance their low-carbon competitiveness.

8.2 Recommendations for implementation

Governments, industry associations, and relevant organizations should promote the dissemination and application of this document.

Such efforts may include:

d) organizing training programmes;

e) providing guidance to support understanding and implementation;

f) facilitating capacity building within the industry.

Policy incentive mechanisms should be established, where appropriate, to encourage participation. These may include:

a) tax incentives;

b) financial subsidies;

c) recognition or award schemes.

Such measures should support enterprises that demonstrate strong performance in carbon emission reduction and achieve higher carbon label grades.

8.3 Review

This document shall be reviewed and, where necessary, revised periodically in response to:

a) technological developments in the global alcoholic beverage industry;

b) changes in carbon emission policies;

c) feedback obtained during implementation.

A comprehensive review shall, in principle, be conducted at least once every three years to ensure the continued scientific validity, advancement, and applicability of this document.

During the revision process, input should be solicited from relevant stakeholders, including:

a) governments;

b) industry associations;

c) enterprises;

d) other interested parties.

Such consultation shall support the continuous improvement of the standard and its alignment with the sustainable Where significant policy changes or technological breakthroughs occur, an ad hoc revision may be initiated.

Where public consultation is conducted, the consultation period shall not be less than 30 working days. Development needs of the global alcoholic beverage industry.

Annex A (normative)

GIS-LCA Methodology

A.1 General

The GIS-based life cycle assessment (GIS-LCA) methodology for carbon footprint quantification of alcoholic beverages is a comprehensive approach developed on the basis of the life cycle assessment (LCA) framework, incorporating Geographic Information System (GIS) technology to enable spatially explicit and refined carbon footprint accounting across the full life cycle of alcoholic beverage products.

This methodology integrates geographically referenced information—such as raw material origins, production facility locations, packaging material sources, transportation routes, and regional energy structures—with life cycle inventory data and emission factors through spatial mapping, spatial analysis, and spatial computation.

By doing so, it effectively addresses the limitations of conventional LCA approaches, particularly with regard to insufficient regional representativeness and limited capability in capturing spatial heterogeneity, thereby significantly improving the scientific validity, accuracy, and comparability of carbon footprint results.

Through the incorporation of higher spatial resolution activity data and region-specific emission factors, the GIS-LCA methodology enables a more realistic representation of carbon emission variations across regions and life cycle stages, including: accurate characterization of regional differences in cultivation practices, energy inputs, and emission intensities for raw material production; refined assessment of carbon emissions associated with transportation distance, routes, and modes across regions; improved quantification of emission variations arising from differences in regional electricity mixes and fuel structures during production and processing.

In addition, the GIS-LCA methodology demonstrates strong practicability and operability. It may be implemented using established GIS-LCA software platforms to support life cycle modelling, spatial data integration, and the calculation and aggregation of carbon emission results.

This Annex specifies the procedures, data requirements, and calculation logic for conducting carbon footprint quantification of alcoholic beverages based on the GIS-LCA methodology.

A.2 System boundary and functional unit

A.2.1 System boundary

The carbon footprint quantification of alcoholic beverages shall cover the complete life cycle from resource acquisition to final disposal. The system boundary shall, in principle, include the following stages:

a) raw material cultivation or procurement;
b) production and processing;
c) packaging and storage;
d) transportation and distribution;
e) storage and consumption;
f) post-consumption waste treatment.

On this basis, the GIS-LCA methodology introduces spatial representation and spatial unit delineation into each life cycle stage. Conventional LCA “process units” shall be further mapped into spatially explicit “spatial process units” with defined geographic attributes, enabling the integration of life cycle boundaries with spatial boundaries.

Within the GIS-LCA framework, the spatial location or spatial extent of each stage shall be defined as clearly as possible, including but not limited to:

a) locations of raw material cultivation or main sourcing regions;
b) locations of production facilities;
c) locations of packaging material production;
d) origins, destinations, and main routes of transportation;
e) locations of waste treatment facilities.

A.2.2 Functional unit

The functional unit shall serve as the reference for quantifying the carbon footprint of alcoholic beverages and as the common basis for aggregating and comparing carbon emissions across spatial units and life cycle stages.

The selection of the functional unit shall be consistent with the production characteristics and market circulation form of the alcoholic beverage product. In general, 1 liter (1 L) of finished alcoholic beverage shall be used as the functional unit.

Within the GIS-LCA methodology, once defined, the functional unit shall remain consistent throughout the entire life cycle assessment and shall not be arbitrarily changed.

A.3 GIS-LCA-based carbon footprint quantification procedure

The carbon footprint quantification of alcoholic beverages based on the GIS-LCA method shall be conducted sequentially following the technical pathway: process identification – spatial mapping – spatialization of activity data – emission factor matching – result calculation and analysis. These steps are interconnected, collectively forming a systematic framework that couples life cycle assessment logic with geospatial information.

A.3.1 Step 1: Identification of Spatial and Process Units

（1）Identification of Life Cycle Process Units

The main process units for each life cycle stage shall be identified in accordance with the actual production processes and supply chain structure of the alcoholic beverage. In principle, the identification shall include, but is not limited to:

a) Cultivation or procurement of raw materials;
b) Core production processes such as fermentation, distillation, and aging;
c) Production of packaging materials, bottling, and storage;
d) Transportation and distribution of finished products.

The identification of process units shall be based on actual production and operational activities, ensuring the completeness and accuracy of the accounting object.

（2）Determination of Spatial Attributes of Process Units

Within the GIS-LCA framework, each process unit shall have clearly defined spatial attributes, establishing a traceable link between life cycle processes and geographic space. Typical spatial attributes of process units include:

a) Geographic coordinates or spatial location;
b) Administrative division;
c) Corresponding power grid region or energy system.

A GIS-LCA platform may be used to establish the mapping relationship between process units and spatial units, providing a spatial foundation for subsequent data collection, emission factor matching, and result analysis.

A.3.2 Step 2: Spatialized Collection of Activity Data

Under the GIS-LCA framework, activity data shall be collected according to the principle of spatial correspondence. Priority shall be given to enterprise-level measured data; alternatively, measured data with clear spatial representativeness or regional statistical data may be used to ensure consistency and traceability between activity data and the corresponding spatial units. Key data collection shall include:

a) Yield, energy consumption, and water usage during the raw material cultivation or procurement stage;
b) Energy consumption data (e.g., electricity, fuel) during production and processing;
c) Quantities of packaging materials used and their main sources;
d) Transport mode, distance, and route for each transportation stage.

If data at the specific site or facility level cannot be obtained, regional average data or typical values may be used as a substitute, but the spatial assumptions and their applicability shall be clearly stated in the accounting report.

A.3.3 Step 3：Spatialized Emission Factor Matching

Based on the defined spatial attributes of process units, appropriate regional emission factors shall be matched to each process unit, ensuring precise correspondence between emission factors and spatial units. The matching of emission factors shall include, but is not limited to:

a) Electricity emission factors for different regions or power grids;
b) Emission factors of different fuel types under specific regional conditions;
c) Unit transportation emission factors for different transport modes in corresponding regions;
d) Agricultural emission factors related to the specific region during the raw material cultivation stage.

A GIS-LCA platform may be utilized to spatially associate and automatically match emission factor databases with process units, reducing human selection bias and improving the accuracy and consistency of emission factor selection.；

A.3.4 Step 4: Life Cycle Carbon Emission Calculation

Upon completion of the spatialized collection of activity data and the spatial matching of emission factors, life cycle carbon emission calculation shall be conducted based on the GIS-LCA method. This step combines life cycle accounting logic with geospatial computation to achieve precise and spatially resolved quantification of carbon emissions for alcoholic beverages.

Within a GIS-LCA software platform, carbon emission calculations shall be performed for each life cycle process unit within its corresponding spatial unit. The basic calculation principle is as follows:：

Carbon emissions of a life cycle stage=∑(Activity data×Corresponding spatial emission factor)

Where both activity data and emission factors are spatially matched to specific spatial units, ensuring consistency of data sources, spatial location, and emission characteristics throughout the calculation.

The carbon emission results for each life cycle stage shall be normalized according to the established functional unit. Under the GIS-LCA framework, carbon emission calculations may be conducted separately for different spatial units. Using the GIS-LCA platform's spatial computation and aggregation functions, stage-wise and region-wise carbon emission results shall be systematically summed to obtain the overall life cycle carbon footprint of the alcoholic beverage.

By introducing spatial unit-level accounting and aggregation in the calculation process, the GIS-LCA method enhances the spatial accuracy and reliability of carbon footprint quantification, providing a robust data foundation for subsequent carbon label classification evaluation and emission reduction decision-making.

A.3.5 Step 5: Result Aggregation and Spatial Analysis

Upon completion of the life cycle carbon emission calculation, the results shall be systematically aggregated and spatially analyzed using a GIS-LCA software platform. This step integrates life cycle accounting results with geographic spatial units, enabling visual representation and refined spatial analysis of carbon emissions.

Within the GIS-LCA platform, spatial computation and statistical analysis functions shall be employed to conduct multi-dimensional analysis of carbon emission results across different life cycle stages and spatial units, including, but not limited to:

Spatial distribution and structural analysis of carbon emission contributions for each life cycle stage;

Spatial differentiation analysis of carbon emission levels among different raw material production regions, manufacturing facilities, or supply chain segments;

Identification and localization of key high-emission spatial units and critical emission processes.

The analysis results shall directly support the classification evaluation of carbon labels for alcoholic beverages, and provide a reliable basis for enterprises to identify priority emission reduction segments, optimize raw material sourcing and supply chain layout, and implement targeted spatially-informed mitigation measure.

A.4 Data Quality and Uncertainty Declaration

Users of this standard, when conducting carbon footprint quantification of alcoholic beverages based on the GIS-LCA method, shall provide a systematic statement on data quality and uncertainty to ensure the credibility, traceability, and auditability of the results.

Within the GIS-LCA framework, data quality control and uncertainty analysis shall be implemented through coordinated management of life cycle accounting logic and geospatial information. The carbon footprint report shall, at minimum, explicitly specify the following:

The sources of activity data and emission factors for each life cycle stage, including their corresponding spatial location or spatial extent, to reflect the spatial representativeness of the data;

The spatial assumptions adopted, including the mapping between process units and spatial units, and the principles for substituting regional data;

The primary sources of uncertainty affecting the accounting results, such as data acquisition accuracy, spatial scale differences, and the applicability of emission factors.

During implementation, the GIS-LCA software platform may be utilized to centrally manage data sources, spatial attributes, and calculation processes. Functions such as spatial association, hierarchical recording, and process traceability shall be employed to enhance the systematic control and consistency of data quality.

When default database values or regional average data are used in place of measured data, the report shall clearly specify the applicable region, spatial scale, and conditions of use, and describe the potential uncertainty introduced. Where necessary, comparative analyses using different spatial scenarios or parameter combinations may be conducted to improve the robustness of the carbon footprint results.

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